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Student Competency Association Analysis for Learning Evaluation Using Apriori Algorithm

Evi Dewi Sri Mulyani[1], Yuda Purnama Putra[2], Egi Badar Sambani[3], Shinta Siti Sundari[4], Teuku Mufizar[5], Muhamad Satrio Nugraha[6]
[1,2,3,4,5,6] Program Studi Teknik Informatika STMIK Tasikmalaya
E-mail: eviajadech@gmail.com

ABSTRACT

Evaluation activities as a process in a learning program are one of the keys to improving the quality of education that will be accepted by students in learning. Therefore, it is important for a teacher in how to understand the lack of learning given to students. Based on this, an analysis was carried out using the Association method with the Apriori Algorithm in finding relationships in the competency value data for each subject. In the Apriori method, it will produce a value that will determine the formation of the pattern. The data used is competency data based on student grades of English class 11 odd semester year class 2019 - 2020 SMK Ar - Rizqi Bina Insani with a total of 108 records with a maximum itemset of 3 itemset. The results of this association analysis produce a relationship between competencies that appear simultaneously, so that it can be used as an evaluation of learning for teachers as a learning improvement strategy for students based on the competence of each subject.

Keywords: learning competence, association rules, apriori.

INTRODUCTION

National education in Indonesia serves as a forum for the development of useful capabilities and character and civilization of the nation in the context of the intellectual life of the nation, as stated in Law Number 20 of 2003 concerning the National Education System. The educational trajectory determines the direction of students in the educational space. Its existence is not a norm, but a fact of reality. Different scenarios for determining this trajectory are possible in different educational conditions [1]. One of the important things that need to be considered is how each competency of this subject can be conveyed and absorbed properly by students. Competence is a major factor found in someone who does have more abilities and makes him different from others in terms of ability. Because the teacher as the main actor in the success of the educational process must of course pay attention to the extent to which the delivery of learning materials is able to increase the value of the competency of the subjects that students have, evaluation becomes a process that can be used by a teacher in analyzing this. Evaluation is a systematic and continuous process to collect, describe, interpret, and present information about a program to be used as a basis for making decisions, formulating policies and developing further programs.

The issue of educational evaluation has long been a research hotspot. Using big data analysis method to conduct educational evaluation can improve the pertinence and effectiveness of education. Conventional A priori algorithm has certain limitations in the application of educational evaluation [2]. Data mining (DM) techniques emerged as an answer because they were used in different research areas (eg. medicine, business, market research, etc.) with a large amount of data provided [3]. It has been defined as “the nontrivial extraction of previously unknown, implicit and potentially useful information from data [4]. Competitive and dynamic market conditions make every company must always observing competition in the business environment, where data processing is expected to provide information that can used to support marketing strategy [5].

Data Mining applied to commercialization makes it possible, among other aspects, to

discover behavioral patterns in clients, which companies can use to create marketing strategies aimed at their different types of clients [6]. Recently, with the advent of data mining methods, many opportunities for improvement in the requirements gathering process have become available, recommendation systems for requirements engineering can be used to provide the right information at the right time to requirements engineers [7]. In data mining, association rules can be defined as filtering variables for further exploration implicit relationships in variables or items in the database [8]. With technology in the field of information is growing, resulting in fast and accurate information more easily obtained among the people today. Utilization of data as information is very much needed in decision makers and knowledge base. Data Mining is more than just traditional data analysis. It uses traditional analysis tools like statistics and graphics in addition those associated with artificial intelligence such as rule induction [9], and also data mining can extract user-related patterns and rules from seemingly unrelated big data [10].

In this case, we can apply the field of data mining to find these patterns. The author uses association analysis with the data to be extracted in the form of competency data from the values possessed by students at SMK Ar - Rizqi Bina Insani which is located at JL. Raya Cijuhung No. 3/5, Sukaratu, Tasikmalaya, West Java. Association analysis is carried out on the appearance of value patterns in each competency that is below the Minimum Completeness Criteria (KKM) or Minimum Completeness Score (SKM). The first stage before the association analysis is carried out, a grouping process will be carried out, namely in the section that discusses about. the process of grouping student data based on the similarity of the KKM value attributes using clustering [11].

In previous research, this association rule can display the pattern of the National Examination subjects needed for the enrichment process of each group of students based on their respective learning abilities [12]. Association rule mining is a well-known approach to finding these patterns [13], association rules also can be used to mine data collected in the investigation to find the relationship between the factors that influence extrinsic motivation [14]. Applying data mining in education allows for a better understanding of how students are progressing. It can also be used to identify ways in which one can improve educational outcomes.

Then determine the minimum support from the association analysis, then calculate the frequent of each competency item from itemset 1 to itemset 3 by calculating the support value. Finally, create an association rule by calculating the minimum confidence and lift value of the selected itemset. Furthermore, the association algorithm is implemented into an application for evaluation of learning using the PHP programming language and MySQL database. In this application, teachers are given facilities in the form of automatic calculation of the evaluation of competency values that the teacher inputs to help facilitate teachers in evaluating learning.

METHODS

The research method used in this research is exploratory where this method in this case states that exploratory research is one of the research approaches that will be used to be able to research something that you do not know, do not understand, or do not know well. The purpose of this research is to explore data by extracting the data obtained to find patterns from the competency value data of each subject so that it becomes knowledge that can help teachers in the learning evaluation process by applying association rules, this activity forms the basis for decision support for decision makers [15].

The KDD dataset which is freely available online can used for experimentation and results are discussed. the aim is to experiment with dfiiferent parameters of apriori algorithm to build a string intrusion detection system using association rule mining [16]. The apriori algorithm is one of the most well-known and

classic algorithms in data mining methods. A priori is used to learn association rules, as well as look for relationships between one or more items in an itemset. Information about the association's rules in purchasing items (menus) by consumers can be used by one of restaurants to create more potential promotional strategies to boost sales by referring to a combination of items that are often purchased simultaneously [17], consumer buying patterns are a form of purchase made by consumers, both one person and many people to get the desired item by making a purchase transaction [18]. The application of the a priori method for the characteristics of families with disabilities with RPD disability data from different manufacturers, where the results of the analysis show that the A priori method can effectively reveal hidden information in disability data, such as AR between vulnerable parts of the RPD, causes of disability, and other factors [19]. in previous research, improved Apriori algorithm is implemented in the mobile ecommerce recommendation system which breaks the limitations of visual interfaces in mobile terminals and constantly generated bulk data [20].

Apriori algorithm is a classic mining algorithm that can mine association rules and sequential patterns. However, when the Apriori algorithm is applied to mining of contiguous sequential patterns, it is inefficient [21]. Approach with a priori algorithm seeks to efficiently find the number of itemset frequency. Finding frequent item set (item sets with frequency larger than or equal to a user specified minimum support) is not trivial because of its combinatorial explosion [22]. Once frequent item sets are obtained, it is straightforward to generate association rules with confidence larger than or equal to a user specified minimum confidence [23]. The main thing in the Apriori algorithm theorem uses the principle if an itemset is frequent, all subsets (parts) of the itemset must also be frequent. The stages in this data mining include (1) Determine the minimum support and confidence of the dataset, (2) Count the items of support by scanning the database for k itemsets. After getting the k-itemset from the k-itemset whether it is above the minimum support, if it exists or meets the minimum support then the k-itemset will become a high frequent pattern. With the following formula:

$$Support = \frac{\Sigma \text{the number of transactions contains A}}{\Sigma \text{ Total transactions}} \text{ x } 100\% \quad (1)$$

(3) Do a combination of the previous k-items, then scan the database again to calculate the items that meet the minimum support as in the previous step where items that meet the support are made candidates, (4) Repeat the steps above until there are no more k-itemsets that meet the minimum support, (5) Then form an association rule based on the minimum confidence and lift value. The formula for calculating the minimum confidence is as follow:

$$Confident\ P(B|A) = \frac{\Sigma \text{ transactions contains A \& B}}{\Sigma \text{ transactions contains A}} \text{ x } 100\% \quad (2)$$

The formula for calculating lift value is as follow:

$$Lift = \frac{Confidence}{Confidence\ Benchmark} \quad (3)$$

To find out the confidence benchmark value, we can calculate it by:

$$Confident\ benchmark = \frac{\text{Total transaction items in consequent}}{\text{Total database transactions}} \text{ x } 100\% \quad (4)$$

RESULT AND DISCUSSION

A. Data Needs Analysis

Analysis of Data Needs. Data collection is done by observing the research site and the writer gets a document in the form of legger / student report cards. After collecting data from the research site, data analysis was carried out by taking data according to the needs of the analysis. The data taken is the competence of the student subjects. The author took data from the value of the English language competence of class XI students in the class of 2019 - 2020 as many as 108 records. From these data, the association analysis process with the apriori algorithm will be carried out at the next point.

B. Association Analysis Discussion

Data Mining in this study uses the Knowledge Discovery in Database (KDD) method and association analysis is carried out using the a priori algorithm, This involves applying various algorithms to find and extract such patterns [24]. The apriori algorithm will calculate the support and confidence values for each item that appears and make it the item that often comes out simultaneously. The lift value is also calculated to see the strength of the association rule. The following are the stages in Knowledge Discovery in Database (KDD):

1) Data Selection: Is the selection or selection of data from a set of operational data that is carried out before the process of extracting information in KDD begins. The data from the selection is stored in a file or file which will be used in the data mining process. Data selection or data selection aims to select relevant data in the research being conducted. In the initial database there are many attributes that are not needed, therefore the data is taken only with the attribute name and competency value whose names are changed to a unique code. The table below shows data on the score of each competency in English subjects from each class XI student in the class of 2019 – 2020.

Table 1. Score Data for Each Competency

No	Nama	P3.1	P3.2	P3.3	P3.4	P4.1	P4.2
1	Abdul Rahim Rizkhy	80	70	70	75	72	75
2	Ageng Saputra	80	70	70	70	72	71
3	Agung Surya Adhari	80	70	70	69	72	69
4	Agus Juliana	80	70	70	70	72	71
5	Ai Teti Barokah	80	70	70	75	72	75
…	…	…	…	…	…	…	…
108	Yajri	60	70	77	83	65	83

The table above has information about the number of data is 108, number of ttributes 7 (P3.1,P3.2,P3.3,P3.4,K4.1,K4.2) and the P3.1 is a competency code

2) Preprocessing / Cleaning: This cleaning process is carried out before the data mining process begins. This cleaning process focuses on removing duplicate data, checking for inconsistent data, and repairing data that has errors such as typos or typographical errors. In addition, the data cleaning process has an enrichment process or the process of enriching data with other relevant information. Data cleaning is carried out before the data mining process begins. In this process, data that has empty values is removed, namely data with the names Siti Nur Aisyah, Imas Siti Fadilah and Sangga Nurmujizatul K so that the total data becomes 105 records.

Table 2. Discarded Data

No.	Nama	P3.1	P3.2	P3.3	P3.4	K4.1	K4.2
43.	Siti Nur Aisyah	0	0	0	0	0	0
63.	Imas Siti Fadilah Sangga	0	0	0	0	0	0
104.	Nurmujizatul K	0	0	0	0	0	0

Preprocessing is done to improve the dataset before the data mining process is carried out. The process includes deleting data that has an empty value attribute that can interfere with the process and data transformation by changing the data to 0 and 1 where 0 is data that is more than KKM and 1 data is less than KKM.

Table 3. Outgoing Item Data

No.	Name	Items Out
1.	Abdul Rahim Rizkhy	P3.2, P3.3
2.	Ageng Saputra	P3.2, P3.3, P3.4, K4.2
3.	Agung Surya Adhari	P3.2, P3.3, P3.4, K4.2
4.	Agus Juliana	P3.2, P3.3, P3.4, K4.2
5.	Ai Teti Barokah	P3.2, P3.3
….	……	……
105.	Yajri	P3.2, P3.3, P3.4, K4.1

3) Transformation: Transformation is a process to transform or combine data into data that is more appropriate in the mining process by means of a summary (aggregation). This process aims to convert or combine data into data that is more appropriate for the mining process. The transformation of the data in this dataset changes the contents of the competency values into 0 and 1 forms where 1 is less than KKM / SKM and 0 is more than KKM / SKM. Transformation of data in datasets.

4) Data Mining: Mining association rules is one of the most important tasks for describing raw data. Although many efficient algorithms have been developed for this purpose, the existing algorithms do not perform well on large volumes of data [25]. Data mining is the process

of looking for a hidden and interesting pattern or information in selected data using certain techniques or methods. This phase is the main phase where we implement the algorithm into the dataset that we have prepared which in this case uses 108 datasets of student competency scores using the apriori algorithm.

The process of forming K-1 or called 1 itemset will be carried out according to the minimum amount of support = 45% with the following equation 1.

As an example :

$$Support\ (P3.1) = \frac{83}{105} x\ 100\% = 79\% \qquad (5)$$

The table below is the calculation of the support value of each item.

Table 4. Support Data Table of each *Item*

Code	Competency	Amo-unt	Supp-ort
P3.1	Analyzing social functions, text structure, and linguistic elements of spoken and written transactional interaction texts that involve the act of giving and asking for information related to identity and family relationships, according to the context of its use. (Pay attention to the linguistic elements of pronouns: subjective, objective, possessive)	83	79%
P3.2	Analyzing the social function, text structure, and linguistic elements of oral and written interpersonal interaction texts that involve the act of extending congratulations, and their responses, according to the context in which they are used.	52	50%
P3.3	Analyzing social functions, text structure, and linguistic elements of spoken and written transactional interaction texts that involve the act of giving and asking for information related to the intention to perform an action/activity, according to the context of its use. (Note the linguistic element be going to, would like to)	75	71%
P3.4	Analyzing social functions, text structures, and linguistic elements of several oral and written descriptive texts by giving and asking for short and simple information related to people, objects and places according to the context of their use.	42	40%
K4.1	Compose short and simple oral and written transactional interaction texts that involve the act of giving and asking for information related to identity, taking into account social functions, text structure, and linguistic elements that are correct and in the context of their use	82	78%
K4.2	Compose simple oral and written interpersonal interaction texts that involve the act of extending congratulations, and their responses by paying attention to social functions, text structures, and linguistic elements that are correct and in context.	43	41%

From the process of forming 1 itemset using a minimum support of 45%, it is known that those who meet the minimum amount of support are in the competencies of p3.1, p3.2, p3.3 and k4.1. then the results of the formation of 1 itemset will be combined with 2 itemsets. For the formation of K-2 or 2 itemset with a minimum amount of support = 45% can be calculated with the following equation:

$$Support\ (A, B) = P\ (A \cap B) \qquad (6)$$

As an example :

Support (P3.1, P3.2) = $\frac{30}{105}$ x 100% = 29% (7)

Table 5. Itemset 2

Competency Code	Total	Support
P3.1, P3.2	30	29%
P3.1, P3.3	53	50%
P3.1, K4.1	82	78%
P3.2, P3.3	22	21%
P3.2, K4.1	30	29%
P3.3, K4.1	52	50%

From the process of Formation of 2 Itemset combinations using a minimum support of 45%, it is known that combinations that meet the minimum amount of support are found in competencies, namely P3.1, P3.3 with 50% support, P3.1, K4.1 with 78% support and P3.3, K4.1 support 50. From the combination of 2 itemsets, 3 itemsets will be formed. For the formation of K – 3 or 3 itemsets with a minimum amount of support = 45%, it can be calculated using the following formula:

$$Support\ (A,B,C) = P\ (A \cap B \cap C) \quad (8)$$

$$Support = \frac{\Sigma \text{transactions contains A \& B \& C}}{\Sigma \text{ Total transactions}} \text{x } 100\% \quad (9)$$

As an example :

$$Support(P3.1,P.3.3,K.4.1) \frac{52}{105} x\ 100\% = 50\% \quad (10)$$

Table 6. Itemset 3

Competency Code	Total	Support
P3.1, P.3.3, K.4.1	52	50%

From the process of Formation of 3 Itemset combinations using a minimum support of 45%, it is known that the combinations that meet the minimum amount of support are found in competencies, namely P3.1, P3.3, K4.1 with 50% support. The process stops until 3 itemsets because there are no more items that can be combined. After the high-frequency pattern is established, then look for association rules that meet the minimum confidence requirements by calculating the confidance value of the associative rules A to B. Minimum Confidance used = 70%. To find the confidence value with following eqution 2

As an example:

Confidence (P3.1, P3.3)→ (K4.1) = $\frac{52}{53}$ x 100% = 98% (11)

Table 7. Formed Association Rules

Association Rules	Support	Confi-dence
(P3.1, P3.3)→ (K4.1) : There is an evaluation relationship between P3.1 and P3.3 competencies, as well as K4.1 competencies.	50%	98%
(P3.3, K4.1)→ (P3.1) : There is an evaluation relationship between P3.3 and K4.1 competencies, as well as P3.1 competencies.	50%	100%
(P3.3)→(P3.1): An evaluation relationship appears on the competence of P3.3, as well as on the competence of P3.1	50%	71%
(P3.1) → (K4.1) : There is an evaluation relationship on the competence of P3.1, as well as the competence of K4.1	78%	99%
(K4.1) → (P3.1) : There is an evaluation relationship on the K4.1 competency, as well as on the P3.1 competency.	78%	100%

5) Interpretation/Evaluation: Interpretation is the process of translating the patterns generated from data mining. Also testing or evaluating the process whether the patterns or information found are in accordance with or contrary to previous facts or hypotheses. In this study, a pattern that has a satisfactory confidence value and a good lift ratio value was evaluated. Then calculate the strength of the rules of the association by looking at the lift value. Lift shows the level of rule strength for random events from antecedent and consequence based on their respective supports. This will provide information about the improvement and increase in the probability of the consequent based on the antecedent. The elevator is defined with

following equationn 3 and 4.
As an example :

$$Confidence\_bechmark\ (K4.1) = \frac{82}{105} = 0.780 \quad (12)$$

$$Lift\_value\ (P3.1, P3.3) \rightarrow (K4.1) = \frac{0.981}{0.780} = 1.26 \quad (13)$$

Table 8. Lift Value Evaluation

Association Rules	Lift
(P3.1, P3.3)→ (K4.1) : There is an evaluation relationship between P3.1 and P3.3 competencies, as well as K4.1 competencies.	1.26
(P3.3, K4.1)→ (P3.1) : There is an evaluation relationship between P3.3 and K4.1 competencies, as well as P3.1 competencies.	1.27
(P3.3) → (P3.1): An evaluation relationship appears on the competence of P3.3, as well as on the competence of P3.1	0.89
(P3.1) → (K4.1) : There is an evaluation relationship on the competence of P3.1, as well as the competence of K4.1	1.27
(K4.1) → (P3.1) : If Competency K4.1 appears to be evaluated, also competency P3.1. will appear for evaluation.	1.27

From the association rules formed based on the selected itemset, namely P3.1, P3.3, K4.1, an evaluation was carried out by calculating the lift value. There is one rule that has a negative or weak correlation, namely the rule (P3.3) → (P3.1) because the lift value is 0.89 or less than 1.

C. Processing with the Weka Tool

Enter the dataset that has been prepared, then proceed with data preparation as shown in the image below.

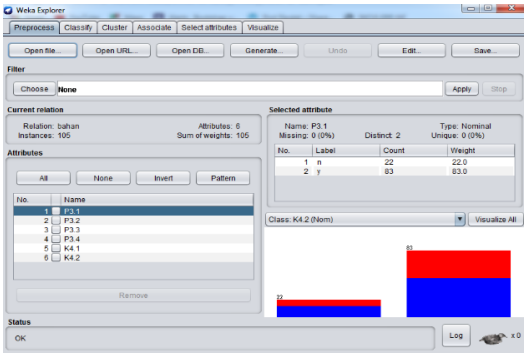

Figure 1. Preprocess Display

After the data is input, then the data can be processed by applying the a priori algorithm After the data is input, then the data can be processed by applying the apriori algorithm. To do this processing, select the associate menu, then chose choose button and then select the association rules to be performed.

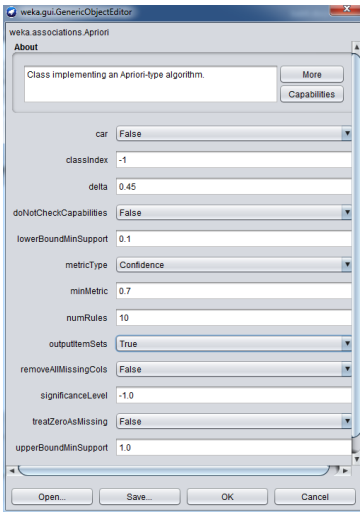

Figure 2. Preprocess Display

To set the minimum support, fill in the delta column, then select the metricType with Confidence and fill in the minMetric field.

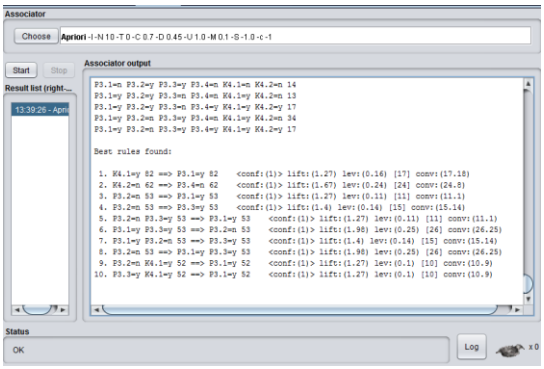

Figure 3. display the results of the association process

In these results, several association rules were formed. The Weka application is able to form association rules according to the wishes of the user. Here the association rules are installed 10 times the rules. In one of the rules, namely (P3.3, K4.1) => P3.1, 100% confidence is found, and the lift value is 1.27 and is in accordance with manual calculations at the previous point.

D. Implementation

Use case diagrams are diagrams that are used to describe application users based on user behavior or actors towards the application used. In this application there is one actor, namely Admin. The admin here has all access rights where he can do all the management and management of the application. The following is a description of the behavior and access that can be used by the Admin.

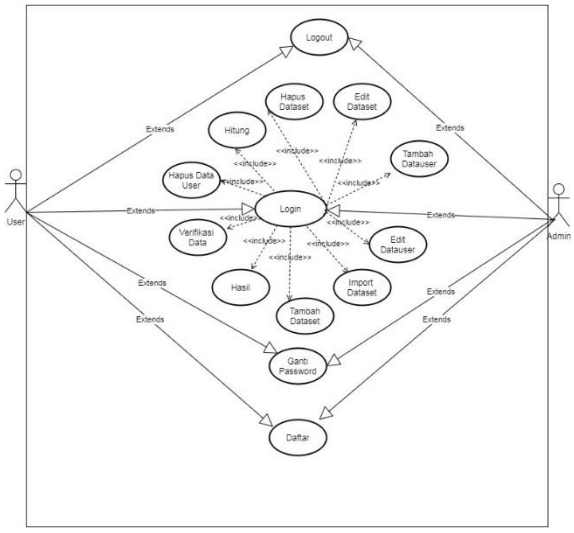

Figure 4. Use Case Diagram

This section describes the application development based on the system design that has been created. The program interface consists of input, which is a format for making choices when the user inputs the system for processing data processing and manipulation. Here is a view of the application.

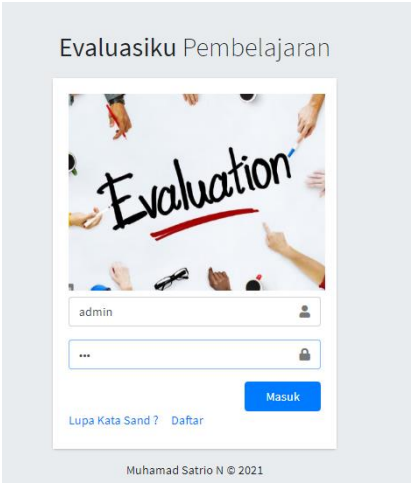

Figure 5. Login Page Display

On the login page, you need to enter your username (with admin) and Password (with 123), write it correctly to enter the main system page. As for the user, enter the username (according to the registered NUPTK) and Password (according to the registered password) write it correctly so that it enters the main system page.

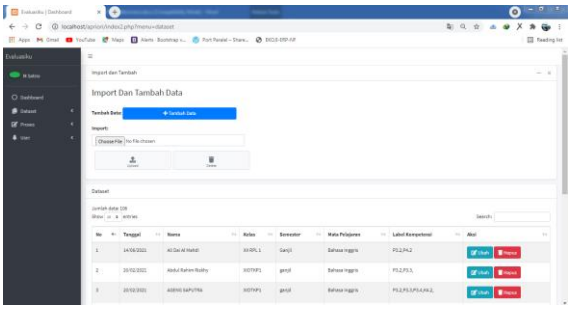

Figure 6. Dataset Display

This page contains data - data sets that exist in the system. The blue frame is the button to add the dataset with the added button one by one or by import via the import button that was pre-filled in the form that has been downloaded in the application and also the delete button which will delete the entire dataset. Furthermore, for the green frame there are 2 option buttons to change the data set via the edit button and the delete button to delete the dataset.

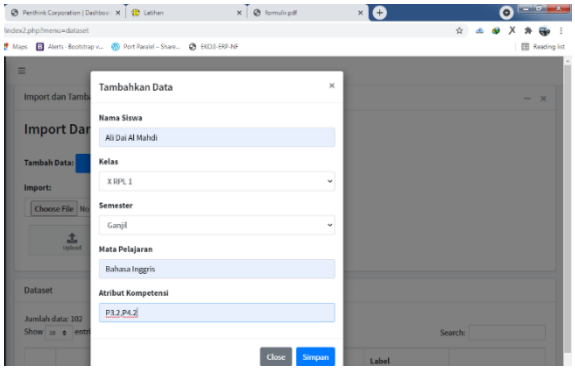

Figure 7. Add Dataset Form

On this page when we press the add user button this window will appear. Fill in the data correctly and accordingly then click save. The data that has been filled in will be entered automatically into the database which we can see on the previous page, namely on the Datauser page.

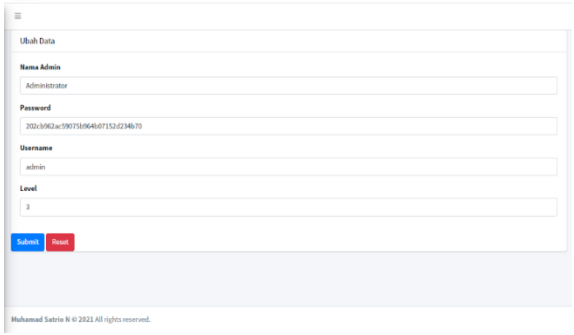

Figure 8. Add Dataset Form

On this page when we press the edit button this window will appear. Change the data correctly and accordingly then click Submit. The data that has been changed will be changed automatically in the database which we can see on the previous page.

tanggal	nama	kelas	semester	matpel	label kompetensi
21/05/2022	Ali Dai Almahdi	XII OTKP 3	Genap	Bahasa Inggris	P3.3,P3.4,K4.1,K4.2,
21/05/2022	Bain	XII OTKP 3	Genap	Bahasa Inggris	P3.4,P3.5,K4.1,

Formisian FormHitungan

Figure 9. Display Sheet Form Fill

Fill in the fields including date, name, class, semester and subject. Leave the competency label because it will be automatically filled in the form on the calculation sheet. Here there are name attributes, P3.1, P3.2, meaning that the P code for knowledge is 3.1 for first knowledge, while K is for skill scores. fill in according to the existing amount. Then fill in the minimum KKM to select what competency codes are selected. The selected code in the attribute table will automatically enter the competency label attribute on the formisian sheet.

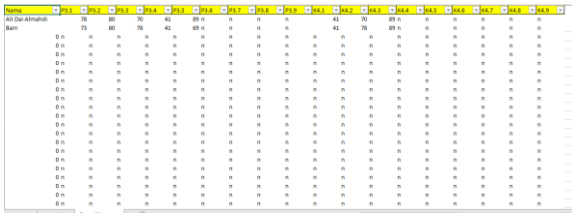

Figure 10. Display Sheet Form Count 1

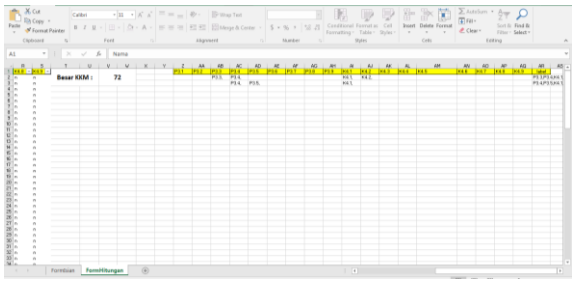

Figure 11. Display Sheet Form Count 2

Fill in according to the existing amount. Then fill in the minimum KKM to select what competency codes are selected. The selected code in the attribute table will automatically enter the competency label attribute on the formisian sheet.

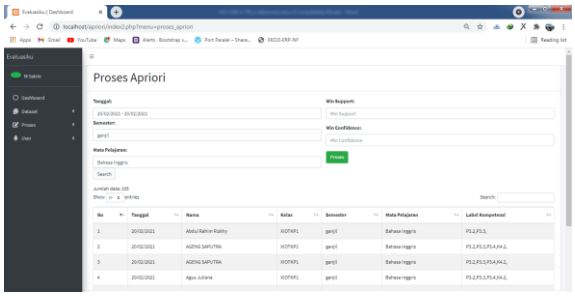

Figure 12. Analysis Process View

As for the process of calculating the association analysis, determine the date,

semester, and subject. Then search by pressing the search button. Next, enter the minimum support and minimum confidence and press the process button. Then the results will appear after pressing the process button

Figure 13. Calculation Result Display

We can see the calculation by clicking on the view rule or download the calculation file to print it by clicking the print button in figure 11.

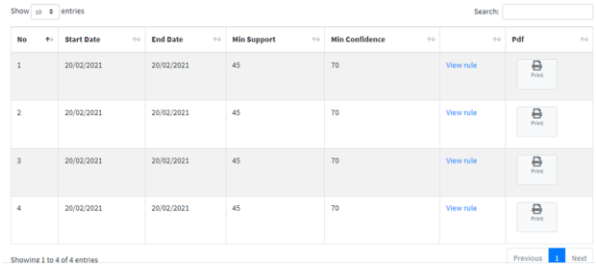

Figure 14. Association Analysis Results Data

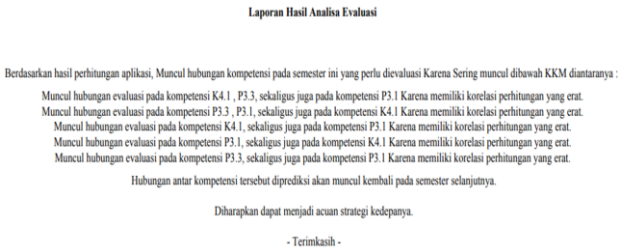

Figure 15. Association Analysis Report Display

The figure 12 is a display of the results of the association analysis results from calculations using the a priori algorithm.

CONCLUSION

With the resulting pattern from the association rules: (a) (P3.1,P3.3)→(K4.1): There is a relationship between the evaluation of competence P3.1 and P3.3, as well as competence K4.1; (b) (P3.3,K4.1)→(P3.1): There is an evaluation relationship between P3.3 and K4.1 competencies, as well as P3.1 competencies; (c) (P3.3) → (P3.1): There is a correlation between evaluation on competence P3.3, as well as on competence P3.1; (d) (P3.1) → (K4.1): There is an evaluation relationship on the competence of P3.1, as well as on the competence of K4.1; (e) (K4.1) → (P3.1): There is a correlation between evaluation on competency K4.1., as well as on competency P3.1. That can help teachers in the learning evaluation process to help learning strategies for teachers in the next semester.

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